Innovative Partnerships Program

Gas-Liquid Supersonic Cleaning and Cleaning Verification Spray System

NASA success story

NASA Kennedy Space Center (KSC) recently entered into a nonexclusive license agreement with Applied Cryogenic Solutions (ACS), Inc. (Galveston, TX) to commercialize its Gas-Liquid Supersonic Cleaning and Cleaning Verification Spray System technology. This technology, developed by KSC, is a critical component of processes being developed and commercialized by ACS to replace current mechanical and chemical cleaning and de-scaling methods used by numerous industries. Pilot trials on heat exchanger tubing components have shown that the ACS technology provides for:

- Superior cleaning in a much shorter period of time.
- Lower energy and labor requirements for cleaning and de-scaling operations.
- Significant reductions in waste volumes by not using water, acidic or basic solutions, organic solvents, or non-volatile solid abrasives as components in the cleaning process.
- Improved energy efficiency in post-cleaning heat exchanger operations.

The ACS process consists of a spray head containing supersonic converging/diverging nozzles, a source of liquid gas; a novel, proprietary pumping system that permits pumping liquid nitrogen, liquid air, or supercritical carbon dioxide to pressures in the range of 20,000 to 60,000 psi; and various hoses, fittings, valves, and gauges. The size and number of nozzles can be varied so the system can be built in configurations ranging from small hand-held spray heads to large multinozzle cleaners. The system also can be used to verify if a part has been adequately cleaned.

Technology Advantages

- Reduction of quantities of hazardous waste: The absence of water, chemical solutions, organic solvents, and/or nonvolatile solids as components in the cleaning process leads to significant reductions in the volume of substances removed during cleaning, as well as elimination of post-cleaning waste treatment requirements.
- Manufacturability: The system utilizes many off-the-shelf parts, which do not require expensive machining.
- Adaptable: The system can be modified to accept virtually any gas or liquefied gas over a wide range of flow rates. In addition, multiple nozzle configurations using large or small nozzles are possible.
- Maintainable: Both orifices are removable for easy cleanout/replacement in case of erosive wear or clogging. Any of the system components can be easily replaced with a minimum of tools and expertise.
- User friendly: The system requires only a minimum of user training. An operator can begin using this system in only a few hours.
- Compact: The nozzles can be made very small (approximately 1/2 inch long by 9/64 inch wide). Configurations can be created that reach into tight places.

- Multidirectional: The nozzle can be oriented in any direction during use without affecting performance. Therefore, all sides of a part can be cleaned without time-consuming reorientation.

Success Highlights

- ACS has successfully developed and utilized a prototype of the Gas-Liquid Supersonic Cleaning and Cleaning Verification Spray System technology utilizing high-pressure, high-velocity cryogenic media to clean heat-exchanger pipes encrusted with very hard and tenacious scale deposits at a chemical processing plant in Texas.
- The Gas-Liquid Supersonic Cleaning and Cleaning Verification Spray System technology has received U.S. Patent # 5,730,806.

The Market

Heat exchangers are used throughout many segments of the chemical processing industry. According to input from the American Institute of Chemical Engineers, there are over 200 manufacturers of heat transfer equipment in the United States. Heat exchanger fouling is significantly important, with an economic impact in the U.S. estimated at 0.3 percent of total industrial output. Despite technical advancements in the design and manufacture of heat exchangers over the past two decades, the problem of fouling on heat exchanger surfaces still remains one of the major unresolved problems in thermal science. It is estimated that fouling in heat recovery and transfer equipment costs U.S. industry approximately $5 billion per year. Roughly 30 percent of U.S. heat exchangers are subject to fouling from hard scale deposits that are very difficult to remove.

Commercial Applications

The system developed by ACS utilizing the Gas-Liquid Supersonic Cleaning and Cleaning Verification Spray System technology has the flexibility and adaptability for use in existing plants using heat exchangers of various designs and operational configurations. ACS will continue developmental studies and pilot testing for application of its system on various types of heat exchangers and will market its system to those industries utilizing those exchangers. In addition to heat exchanger applications, ACS is adapting the system for numerous applications including: cleaning of coated or contaminated surfaces, air and sea infrastructure applications, mining, natural gas and oil exploration, and numerous other potential uses.

The commercial success of the KSC Gas-Liquid Supersonic Cleaning and Cleaning Verification Spray System technology is the result of NASA's technology transfer program under the Innovative Partnerships Program. This program seeks to stimulate commercial use of NASA-developed technologies. If your company is interested in learning more about the NASA technology transfer process, please contact:

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